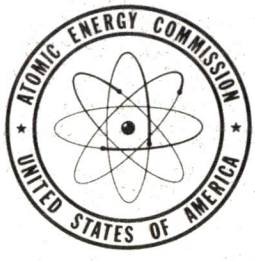

UNITED STATES ATOMIC ENERGY COMMISSION

UCLA-182
HEALTH AND BIOLOGY

FIELD OBSERVATIONS AND PRELIMINARY FIELD DATA OBTAINED BY THE UCLA SURVEY GROUP ON OPERATION JANGLE, NOVEMBER 1951

BY

K. H. LARSON, J. H. OLAFSON, H. M. MORK,
D. R. HOWTON, AND THE ALAMOGORDO SECTION STAFF

JANUARY 30, 1952

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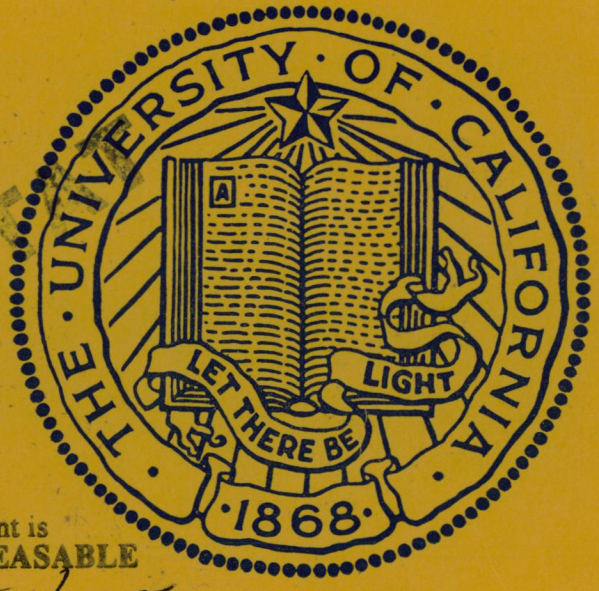

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and

The Alamogordo Section Staff

91812-50025

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ABSTRACT

This report summarizes the observations on each of the Detonations and preliminary data on the area contaminated by the respective Fall-out materials obtained by the U.C.L.A. Survey Group on Operation Jangle, Nevada Test Site, November, 1951.

On the basis of this group's limited radiological measurements an estimated pattern of Fall-out has been suggested for each of the Detonations. The Surface Detonation Fall-out first occurred at a point approximately eighteen miles from Ground Zero, three to five miles wide fanning outward to at least fourteen miles wide at thirty-two and thirty-six miles from Ground Zero. The Fall-out from the Underground Detonation contaminated a continuous area in a V-shaped pattern, the maximum probable width being twenty-eight miles at thirty-two to thirty-six miles from Ground Zero.

At twenty-eight miles from the Surface Detonation Ground Zero, Fall-out radiation was first detected at H hour plus thirty-one minutes with the maximum of 2.2 r/hr. recorded at H hour plus thirty-eight minutes. This radioactivity is contained in glass-like beads only, eighty-one per cent of which is found in the 75-150 micron range in surface soil samples collected at thirty-one miles from Ground Zero (Stone Cabin). However, only irregularly shaped, very friable dark colored particles are believed to constitute the Fall-out from the Underground Detonation.

The first crop of radishes grown on the soil contaminated by the Underground Detonation has absorbed a significant percentage of the radioactive Fall-out material. A significant amount (>ten per cent) of the surface contamination from the Underground Detonation is water soluble and is at this early date (eight weeks) 1-1/2 inches below the surface.

FIELD OBSERVATIONS AND PRELIMINARY FIELD DATA OBTAINED BY THE U.C.L.A. SURVEY GROUP ON OPERATION JANGLE, NOVEMBER, 1951

INTRODUCTION

During the week of September 10 to 16, 1951, the Field Survey Party established forty-four permanently marked soil sampling stations in the area north and east of the detonation sites along the proposed line of Fall-out (34 degrees east of north) for Operation Jangle. At this time also, several background samples of representative flora and fauna from the area were collected. These represented several miscellaneous plant species and eleven rabbits taken along the proposed line of drift for the radioactive "Clouds" resulting from these detonations.

On October 1, 1951, a proposal was submitted to the Division of Biology and Medicine, Atomic Energy Commission for the purpose of collecting Fall-out material from the detonations on soil flats placed along the line of Fall-out in the previously surveyed area. The approved proposal was concerned only with the area beyond the northern boundary of the Test Site reservation. The primary objective of the research is to obtain data for the first time on the uptake of radioactive fission product contamination (Fall-out) from an agricultural soil by a cultivated crop through continuous cropping following a Surface or Underground Atomic Detonation. This information should be useful in interpreting the effects of an Atomic Detonation in or near any major agricultural area within the United States.

Secondary objectives included obtaining information on various factors; such as particle size, solubility, cation and anion analysis

of Fall-out particles; decay and energy curves; weathering of the Fall-out material, as well as other information gained from laboratory studies of the material collected. Observations of the detonations and estimates of Cloud size, direction and velocity of drift, estimated pattern of Fall-out, etc., were made which will aid in the overall biological evaluation of Fall-out from these detonations.

PREPARATORY WORK

Flats of Tujunga soil, a representative California agricultrual soil type, were prepared at the laboratories on November 10 and transported on November 12 to the Nevada Test Site. During the day and one half prior to the tentatively scheduled date for the Surface Test, seventeen flats were distributed in the area of the proposed line of Fall-out, seven along the roads thirty to forty miles from Ground Zero, and ten along the roads roughly circumscribing an arc, approximately twenty miles from Ground Zero. The Fall-out from the Surface Detonation did not contaminate any of these flats.

Sixteen additional flats were then distributed extending the arcs prior to the Underground Test. The final pattern of Flat distribution covered an arc of approximately thirty-five degrees (from twenty degrees east of north to fifty-five degrees east of north) at a distance of twelve to twenty-three miles from Zero and an arc of approximately forty-three degrees (from five degrees east of north to forty-eight degrees east of north), at a distance of about thirty to forty miles from Zero. Porcelain pans for collecting dust particles were placed with some of the soil flats nearest the originally proposed line of

drift, thirty-four degrees east of north, to obtain additional material for laboratory studies. The map (Fig. 1) shows the distribution of flats and dust pans just previous to and at the time of the Underground Test.

FIELD OBSERVATIONS

Surface Detonation: On November 19, 1951, the Surface Test was observed at nine a.m. by three of the authors (K. H. Larson, J. H. Olafson and H. M. Mork) from a reservoir located south of the Stone Cabin, approximately twenty-eight miles from Ground Zero on an azimuth of about eleven degrees east of north*. The height of the Cloud was estimated by triangulation methods to have been about 14,000 feet above Ground Zero level, less than forty seconds after H hr. Later readings, which were affected by the drift of the Cloud towards the observation point (reservoir), gave values upwards to 20,000 feet at 3.5 minutes after detonation. The maximum diameter of the base of the column, calculated from the observed angle between the left and right sides, was approximately 2600 feet, or one-half mile. Almost immediately after the Cloud reached full height th upper portion began to move rapidly in a northeasterly direction. For the first fifteen minutes the angular velocity of the upper leading edge of the Cloud was approximately 1.5 degrees per minute, which gave an estimated linear velocity component of thirty-five miles per hour at a right angle to the line of sight.

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* Obtained from a map supplied this group by Mr. H. Schulte, Group Leader, Industrial Hygiene Group, Los Alamos Scientific Laboratory. Scale: one inch equals three miles. See appendix.

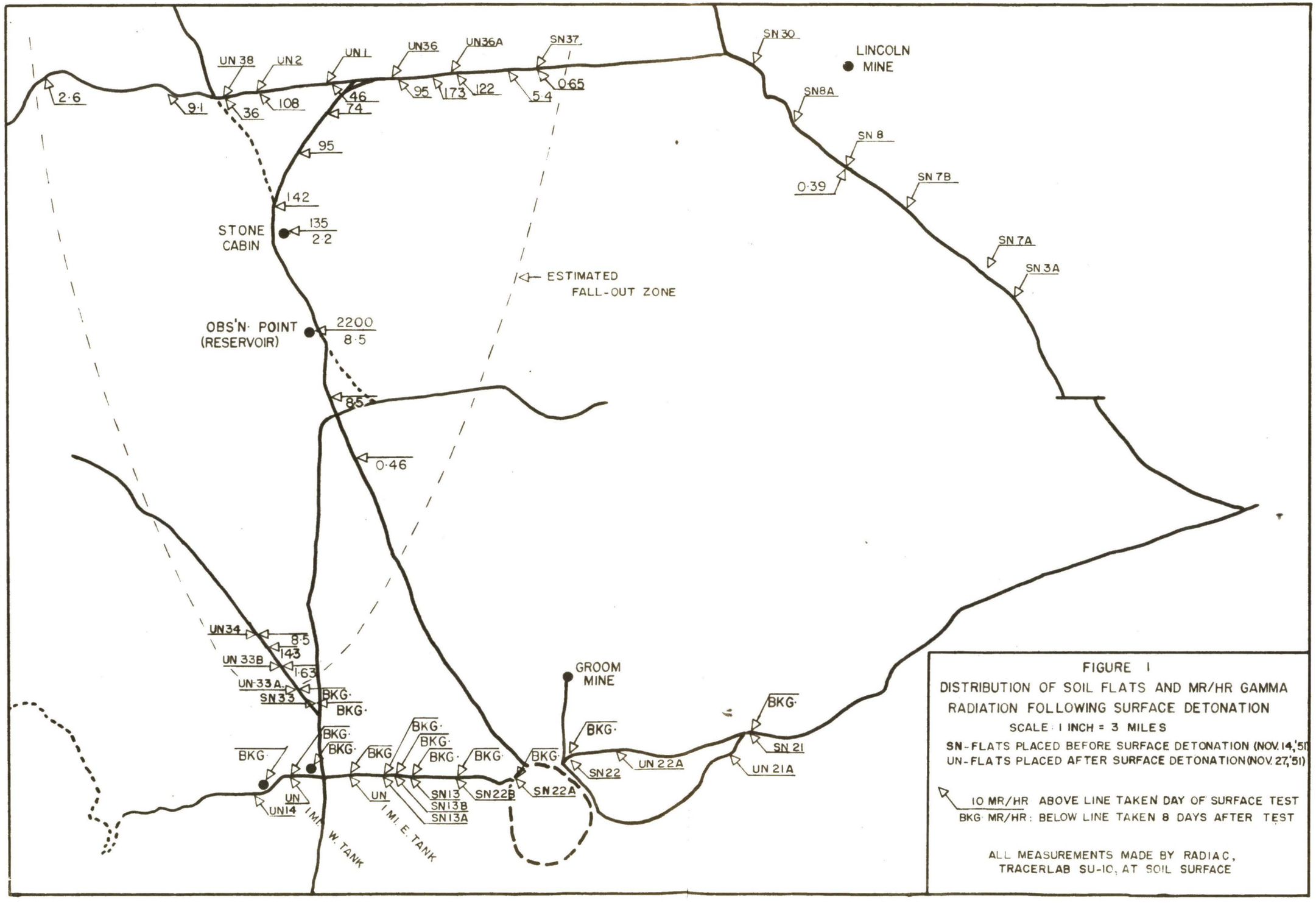

FIGURE 1

DISTRIBUTION OF SOIL FLATS AND MR/HR GAMMA RADIATION FOLLOWING SURFACE DETONATION

SCALE: 1 INCH = 3 MILES

SN - FLATS PLACED BEFORE SURFACE DETONATION (NOV. 14, '51)

UN - FLATS PLACED AFTER SURFACE DETONATION (NOV. 27, '51)

10 MR/HR ABOVE LINE TAKEN DAY OF SURFACE TEST

BKG MR/HR: BELOW LINE TAKEN 8 DAYS AFTER TEST

ALL MEASUREMENTS MADE BY RADIAC, TRACERLAB SU-10, AT SOIL SURFACE

However, by radiation measurements there were surface components which were very different. The sound wave reached our observation point in one minute and fifty-three seconds, equivalent to an average of 1308 feet per second. No air-borne pressure wave or shock through the ground was detectable at this point, twenty-eight miles distant, by any of the three observers.

Thirty-one minutes after H hr. a perceptible rise in background was detected by a G. M. type survey meter (Nuclear Instrument, Model 2611). In less than two minutes later, readings of over twenty milliroentgens per hour were obtained. The Tracerlab SU-10 Radiac Gamma Survey Meter indicated a steady and rapid rise during the next five minutes. At thirty-eight minutes after H hr., a reading of 2.2 r/hr gamma radiation was obtained. Knowing the time of H hr., our approximate distance from Ground Zero and time of Fall-out, the Cloud was travelling at approximately fifty-seven miles per hour when passing over the reservoir. A ground wind, estimated at approximately fifteen miles per hour, was blowing from the south at this time.

During the following twenty to thirty minutes, readings of 2.2-2.8 r/hr intensity were routine inside the closed vehicle cab as the party drove out of the area going north to and west along the east-west road approximately thirty miles from Ground Zero. On the basis of one check, readings taken in the closed cab of the vehicle and outside on the ground surface of the same location, indicated the gamma radiation intensities in the cab were approximately sixty per cent of the intensity measured outside the vehicle. When a relatively lesser

radioactive area had been reached, Soil Station #39, a rough decay curve was obtained from light contamination on the ground. Starting at H plus two hrs., the half-life of the Fall-out was approximately 14.6 minutes. The rate of decay fell off very rapidly and by H plus four hrs., the half-life was about 106 minutes. Virtually all the measurable radiation was gamma, as evidenced by nearly identical decay curves obtained with two beta and gamma instruments, one operating with the shield open and the other with it closed. With either instrument alone, no significant difference was discernible as regards beta or beta plus gamma radiation. The gamma radiation measured inside the vehicle cab in this area at H hr. plus two hrs. and forty minutes was 30 mr/hr by Proteximeter.

Based on radiation measurements, some made during the afternoon following the Detonation and others made eight days later, an approximate pattern of Fall-out was established outside the Test Site reservation. Fall-out first occurred at a point approximately eighteen miles from Ground Zero on an asimuth of about fifteen degrees east of north. From a width of three to five miles at the southern tip, the Fall-out pattern fanned out to at least a width of fourteen miles at thirty-five miles from Ground Zero. The line of drift over this sector was almost due north. No attempt was made to further delineate the area of Fall-out. Table I summarizes the data obtained. See Fig. 1 also.

Table I

A SUMMARY OF BETA-GAMMA RADIOACTIVITY MEASUREMENTS, AS MR/HR SURFACE DETONATION

All measurements were taken one to two inches above the normal soil surface except where otherwise indicated.

Location	Milli-roentgens per Hour		
	Gamma* H +5-8 Hrs.	Gamma H hr.+8 Days	Beta & Gamma H hr.+8 days
4.6 mi. E. of Stake 39	9.1	---	---
Stake 38	36.0	0.46	1.04
6.8 mi. E. of Stake 39	120.0	---	---
8.9 mi. E. of Stake 39	46.0	---	---
10.8 mi. E. of Stake 39	95.	---	---
11.8 mi. E. of Stake 39	173.	---	---
12.5 mi. E. of Stake 39	122.	---	---
14.4 mi. E. of Stake 39	5.4	---	---
Stake 37	0.65	---	---
1 mi. N. of Stone Cabin	142.	---	---
Stone Cabin	95-135	2.2	10.4
Roof of tent, adjacent to Stone Cabin	173.	---	---
Inside tent, on soil adjacent to Stone Cabin	23.	---	---
3 mi. N. of Stone Cabin	95.	---	---
5 mi. N. of Stone Cabin	74.0	---	---
Reservoir	2.2 R at H hr.+34 min.	8.5	14.3
2 mi. S. of Reservoir	---	8.5	22.3
4 mi. S. of Reservoir	---	0.46	10.4-1.04
2 mi. N.W. of Stake 33	---	1.6	6.5
2 mi. N.W. of Stake 34	---	8.5	18.3
2 mi. W. from S. Road Junction with road 40 mi. N. of Zero	---	1.04	1.83
4 mi. W. from S. Road Junction with road 40 mi. N. of Zero	---	1.83	4.4

* The readings obtained at H +5-8 hrs. were measured by a Radiac, Tracerlab Instrument, Model SU-10. The readings obtained eight days after the Detonation were measured by a Nuclear Instrument, Model 2611.

Underground Detonation: On November 29, 1951, at twelve noon, the Underground Test was observed by two of the authors* (J. H. Olafson and D. R. Howton) from a point twenty-three miles northeast of Zero (fifty-four degrees east of north). The estimated height of the cloud reached approximately 10,000 feet above Ground Zero level in two to three minutes. The diameter of the apparent Cloud top was estimated to be 4,300 feet or 0.81 miles. Almost immediately following the Detonation the Cloud appeared to begin to move in a generally northerly direction. A diffuse leading point developed from somewhat over mid-height on the column, while the uppermost portion moved in a more easterly direction giving an appearance of trailing. The leading edge initially moved with an estimated velocity of 800-900 feet per minute (nine to ten miles per hour). Velocity of the drift increased with time. The basal portion of the Cloud appeared to remain nearly stationary over the site of Detonation. As the bulk of the Cloud slowly moved northward, Fall-out could be seen under the leading portion appearing much like a heavy rain shower. When the bulk of the Cloud had passed from line of sight, a haze remained almost obscuring from view the mountains west of the path of the Cloud. This condition persisted for at least an hour following the passage of the Cloud. The sound wave was observed in three distinct parts, a rumble preceding a sharp jolting report followed by a second rumble much like the first, one minute and thirty-five seconds after Detonation. No air pressure or wave front was detectable otherwise. See Figs. 2 and 3.

---

* Mr. K. H. Larson was present at Control Point, Test Site, as a "non-working observer."

15 Seconds

2 Minutes 45 Seconds

5 Minutes

8 Minutes

10 Minutes

12 Minutes 30 Seconds

16 Minutes

22 Minutes

Fig. 2. DEVELOPMENT OF CLOUD FROM THE UNDERGROUND DETONATION

A series of photographs of the Cloud from the Underground Detonation: 15 seconds to 22 minutes inclusive, taken 23 miles from Ground Zero, 54° E. of N.

PHOTOGRAPHY BY J. H. OLAFSON. DEVELOPMENT AND COMPOSITE BY P. KALIAN. AEP. UCLA

27 Minutes

37 Minutes

47 Minutes

53 Minutes 30 Seconds

60 Min: Upper portion drifting easterly.

60 Min: Lower portion drifting northerly.

Fig. 3. DEVELOPMENT OF CLOUD FROM THE UNDERGROUND DETONATION

Continuation of a series of photographs from Fig. 2: 27 minutes to 60 minutes inclusive, taken 23 miles from Ground Zero, 54° E. of N. Note the two parts of the 60 minute photographs, one showing the lower portion of the Cloud drifting northerly and the other showing the upper portion of the Cloud drifting easterly.

The only measurements of radioactivity made on the day of the Underground Detonation were near the eastern limit of the thirty to forty mile arc. Only low intensity readings were obtained, ranging up to 10.4 mr/hr gamma and 32 mr/hr total beta and gamma at Soil Flat 8 on the line thirty-four degrees east of north, thirty-seven miles from Zero. These readings were obtained at H + 3-1/2 hours.

On H hr. + 2 days following the Detonation, readings were taken at the location of all the soil flats and several intermediate points along the east-west roads, approximately twenty and forty miles from Zero. From these readings the Fall-out pattern was roughly determined. The heaviest Fall-out covered a relatively narrow band running slightly east of north. Towards the east a relatively broad area was covered with decreasing amounts of Fall-out. The western border appeared to break off more sharply, but was not definitely fixed. From incomplete data, it appears that a forty-five degree sector was affected by Fall-out for at least the first forty miles from Zero. At thirty-two to thirty-six miles this was approximately twenty-eight miles wide. Fig. 4 summarizes and illustrates these observations.

LABORATORY STUDIES OF FALL-OUT MATERIAL FROM THE SURFACE AND UNDERGROUND DETONATIONS

Rate of Decay: Decay curves were initiated on Fall-out material from both Detonations as soon as possible after returning to the laboratory. These are still in progress and will be continued as long as possible on the basis of activity levels. Table II presents a comparison of apparent (average) half-life values of the fission product Fall-out at

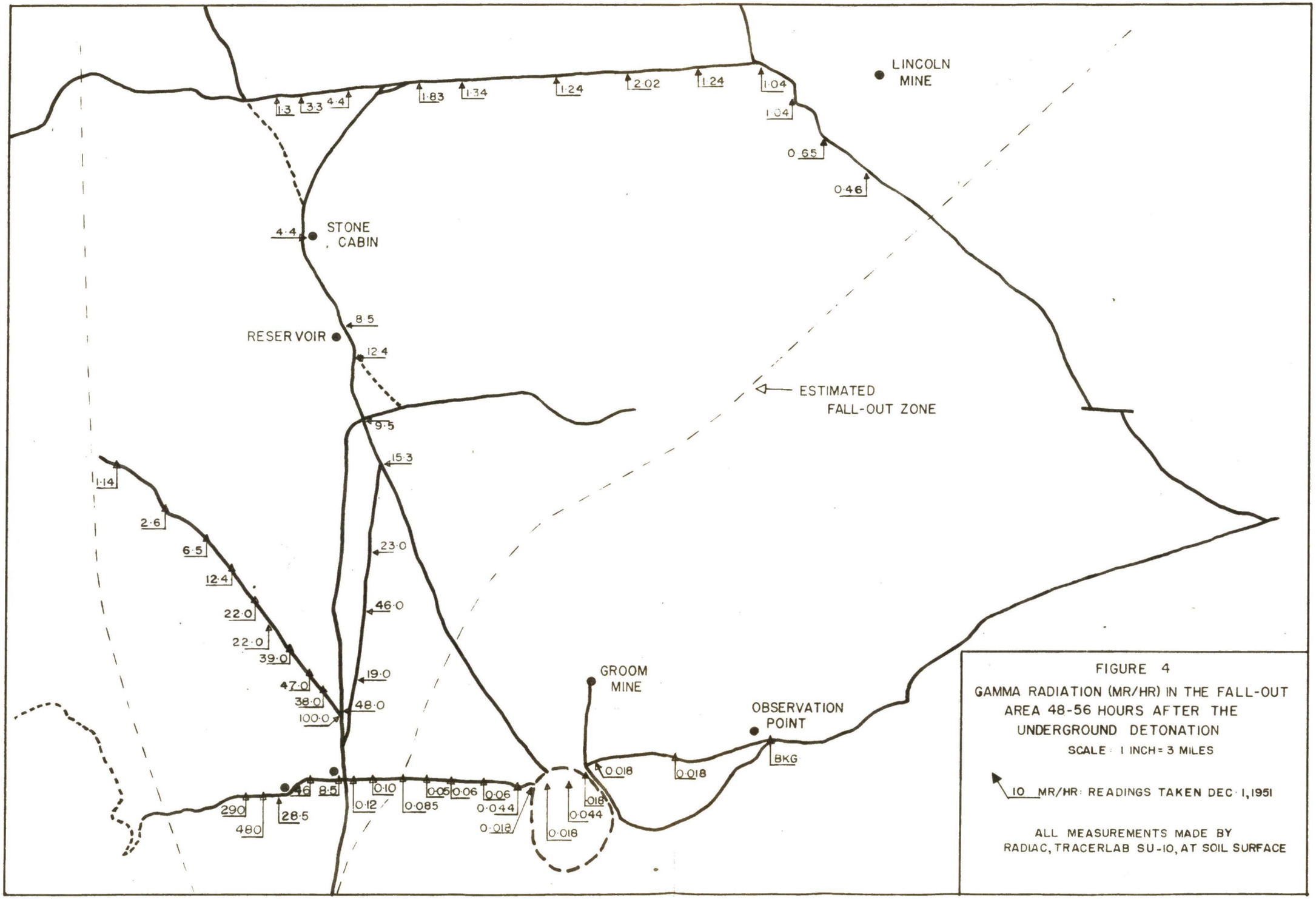

FIGURE 4

GAMMA RADIATION (MR/HR) IN THE FALL-OUT AREA 48-56 HOURS AFTER THE UNDERGROUND DETONATION

SCALE: 1 INCH = 3 MILES

10 MR/HR: READINGS TAKEN DEC. 1, 1951

ALL MEASUREMENTS MADE BY RADIAC, TRACERLAB SU-10, AT SOIL SURFACE

several comparable time intervals following the two tests. Up to the present time the average half-life of the Surface Detonation fission products is significantly longer than for the Underground Test.

Table II

A COMPARISON OF AVERAGE HALF-LIFE OF FISSION PRODUCT FALL-OUT FROM THE SURFACE AND UNDERGROUND TESTS

Time from H hr. (In Hours)	Surface* (In Hours)	Underground** (In Hours)
100	37.5	---
200	70.	61.
300	99.	68.
400	137.	118.
500	225.	161.
600	275.	207.
700	293.	280.

* Average of four samples.
** Average of five samples.

Energy Absorption Studies: Energy absorption curves have been run on selected samples from each of the two Test Detonations. Due to uncontrollable variables including differences in mass of samples, a strict comparison of data is not feasible at this time. The most striking feature of all energy curves run to date on these samples is the heavy preponderance of very soft beta radiations. In general, about fifty per cent is absorbed by 28.5 mg/cm^2 of aluminum. Less than five per cent penetrates 220 mg/cm^2 aluminum or over, indicating that very minute amounts of gamma emitters are currently among the fission products resulting from these Detonations.

Particle Size Studies of Fall-out from the Surface Detonation: Only small glassy beads have been found to contain the radioactivity collected from this test. Individual beads have been isolated from clothing and equipment, and from soil samples taken at the Stone Cabin, thirty-one miles from Ground Zero. Virtually all the particles thus isolated and measured under the microscope were approximately 150 microns in diameter. These particles were all from the Fall-out at thirty to forty miles from Ground Zero. Mechanical analysis by sieving a soil sample taken at the Stone Cabin, thirty-one miles from Ground Zero, showed about eighty-one per cent of the radioactivity in the 75-150 micron fraction and fifteen per cent in the 150-250 micron range. Much lesser amounts of radioactivity were found in coarser and finer fractions. The flotation technique of separating the activity from the Stone Cabin sample yielded seventy per cent of the radioactivity which was concentrated in the fraction that floated in a liquid having a specific gravity of 2.74. This separation indicates the definite physical characteristics of the active material. See Fig. 5.

X-ray diffraction patterns of the glassy beads were made using the 57.3 mm Debye camera. Only one diffraction line, 4.15 Å, was obtained from the material after a twenty-three hour exposure using Cu Kα. Increased length of exposure was prohibited by the activity of the sample. Emission spectrographic analysis of the beads gave the following results: Major constituents: Ca, Si, Ag

Minor constituents: Mg, Ni, Fe

The only materials which would be consistent with this analysis are α tridymite and β cristobalite.

Fig. 5. Glass-like Beads Separated
From Fall-out Material from Surface Detonation

The particle size range is 125-150 microns. These beads were separated from the surface soil samples collected at the Stone Cabin, thirty-one miles from Ground Zero.

Particle Size Studies of Fall-out from the Underground Detonation: All attempts to isolate finite particles from the Fall-out of the Underground Detonation have been fruitless. Microscopic examination of contaminated soils show irregularly shaped dark colored particles which are believed to be the Fall-out material. Flotation techniques, which have given good results in concentrating the radioactivity in soils from the Alamogordo Area in New Mexico, and from the recent Surface Detonation contamination, have been found inadequate in dealing with

materials from the Underground Test in Nevada. It has been found that the activity from the Underground Test floated in liquids of various specific gravities with no one sharp separation.

Mechanical separation of several soil and dust samples contaminated by Fall-out from the Underground Test show that from eighty-five to ninety-eight per cent of the radioactive Fall-out materials are less than 150 microns in size. One soil sample, collected from west of the Windmill, approximately twelve miles north-northeast of Ground Zero, had forty to fifty per cent of the activity in particles smaller than forty-four microns and only 2.5 per cent in the range above 150 microns. Typical data are presented in Table III.

Alpha Emitter Assays: Soil samples from an area approximately twelve miles north of Ground Zero for the Underground Test have been assayed for plutonium content by a modified TTA extraction method and for total alpha content by solution method. The surface one-half inch of soil (particles < 840 microns) has an alpha activity due to plutonium of 4.75 dis/min/gm of soil. On samples of < forty-four micron soil, the total alpha count is 242 dis/min/gm of soil.

Solubility Studies on Fall-out Material on Soil: The solubility of Fall-out from the two Tests in water and acids has been partially investigated. The material from the Surface Detonation is not significantly soluble at this time. The Fall-out particles smaller than forty-four microns from the Underground Test are somewhat soluble in water and fairly soluble in mineral acids at twenty-five degrees C. This was determined by extracting one gram samples of a contaminated soil sample

Table III

PARTICLE SIZE ACTIVITY DATA, UNDERGROUND TEST

Particle Size Microns	UN 1 Top Soil			BW Top Soil			SN 8 Dust*			SN 8A Dust*			SN 30 Dust*		
	% By Wt.	Dis/ Sec/ Gm	% Ac- tivity	% By Wt	Dis/ Sec/ Gm	% Ac- tivity	% By Wt	Dis/ Sec/ Gm	% Ac- tivity	% By Wt	Dis/ Sec/ Gm	% Ac- tivity	% By Wt	Dis/ Sec/ Gm	% Ac- tivity
>840	49.7	1.94	7.8	---	---	---	---	---	---	---	---	---	---	---	---
250-840	15.7	1.34	2.3	24.4	144.	2.1	15.2	208.	1.9	11.2	317.	1.9	24.5	504.	5.5
150-250	7.3	3.21	1.9	17.1	21.0	0.2	32.6	170.	3.4	29.5	198.	3.1	28.7	526.	6.8
74-150	7.8	57.0	35.7	23.3	2052.	29.4	32.8	332.	6.6	34.6	387.	7.1	30.7	1103.	15.2
44- 74	5.8	48.4	22.6	13.3	3236.	26.4	15.0	5351.	48.8	17.1	3955.	36.0	13.1	6202.	36.4
<44	13.7	26.9	29.6	21.9	3118.	41.9	4.4	14676.	37.2	7.6	12852.	51.9	3.0	26684.	36.1

* Collected in porcelain pans distributed November 14, 1951 and picked up December 2, 1951.

(< forty-four micron fraction) with three successive portions of solvent. The samples were mechanically agitated for an hour, centrifuged at 2000 RPM for an hour and the supernatant assayed for activity. Table IV summarizes the data obtained.

Table IV

PRELIMINARY SOLUBILITY OF UNDERGROUND TEST FALL-OUT IN VARIOUS SOLVENTS AT 25° C

	Per cent of Activity Dissolved in One Hour			
Solvent	First Extraction	Second Extraction	Third Extraction	Total
Water	5.42	3.91	1.16	10.49
0.1 N HCl	24.89	8.72	4.30	37.91
6 N HCl	46.19	5.00	1.71	52.90
6 N HNO_3	36.68	6.19	1.88	44.75

In a second experiment two one gram samples of the < 44 micron fraction were refluxed for an hour with 6 N hydrochloric acid and with aqua regia. This treatment dissolved 59.2% of the activity in the HCl and 44.5% in aqua regia.

Greenhouse Studies on the Uptake of Fission Product Activity Deposited on Soil from the Underground Test by Radishes: Radishes were planted December 7, eight days after Detonation in the eighteen flats contaminated by Fall-out from Jangle #2, as well as in two flats of control soil. To date only incomplete data on uptake are available, but these do indicate an uptake of radioactivity even at this early date. Spot checks of activity in the leaves of the radishes on December 26, H hr. plus 27 days, showed the maximum activity to be sixty-six disintegrations

per second per gram dry matter. On January 8, 1952, forty days after the Bomb Test, a spot check was made on soil activity in the surface one-fourth inch and on the activity in radishes growing in several flats. Table V summarizes these data and also includes counting data of two different time intervals on surface (0-1/4 inch) soil samples removed from the flats before the crop was planted. This serves to indicate that factors other than decay are acting in reducing the surface activity in the flats. It is known that downward leaching of finite particles, as well as the soluble fraction by irrigation water is the major factor involved. At this time (8 weeks) radioactivity is found 1-1/2" below the surface.

Table V

SOIL ACTIVITY AND RADISH PLANT UPTAKE DATA,
FALL-OUT FROM UNDERGROUND TEST

	Soil Activity Data, Dis/Sec/Gm			Plant Activity, Dis/Sec/Gm	
Date Sampled	12- 5-51	12-5-51	1-8-52	1-7-52	
Date Counted	12-14-51	1-8-52	1-8-52	1-8-52	
Flat No.				Tops	Roots
UN 14	2700.	797.	239.	22.9	11.5
UN 1 mile west	1980.	599.	50.7	10.3	9.7
UN 33 B	2420.	678.	93.0	13.4	17.5

CONCLUSIONS AND SUMMARY

This report summarizes the observations on each of the Detonations and preliminary data obtained by this group on Operation Jangle, November, 1951 from areas contaminated by the Fall-out from the Surface and Underground Detonations. The observations and other data obtained to date may be summarized as follows:

1) Observations and measurements made during the two Detonations are as follows:

	Surface Detonation	Underground Detonation
Time and date	0900, 11-19-51	1200, 11-29-51
Observation Point	Reservoir	At Weather Shack, E. of Groom Lake
Distance from Ground Zero	28 mi.	23 mi.
Direction from Ground Zero	11° E. of N.	54° E. of N.
Height of Cloud above Ground Zero	14,000 feet	10,000 feet
Diameter of base of Column	2,600 feet	4,300 feet
Time of maximum dimensions of Cloud after H hour	<40 sec.	2 to 3 min.
Estimate rate of travel of the leading edge of Cloud	57 mi. per hr.	9 to 10 mi. per hr.
Time after H hour at which sound wave was observed	1 min. 53 sec.	1 min. 35 sec.
Air-borne pressure wave	None detectable	None detectable
Shock through ground	None detectable	None detectable

2) On the basis of this group's limited radiological measurements an estimated pattern of Fall-out has been suggested for the Fall-out from each of the detonations with respect to the surface contamination. Fall-out from the Surface Detonation first occurred outside of the reservation at a point approximately eighteen miles from Ground Zero on an azimuth of fifteen degrees east of north. From a width of three to five miles at the southern tip the pattern fanned outward to at least fourteen miles wide at thirty-two to thirty-six miles from Ground Zero. The Fall-out from the Underground Detonation contaminated a continuous area in the pattern of a V, the width at thirty-two to thirty-six miles from Ground Zero, being about twenty-eight miles.

3) At twenty-eight miles from the Surface Detonation Ground Zero, the radiation from the Fall-out was first detectable at H hr. plus thirty-one minutes with the maximum of 2.2 r/hr recorded at H hr. plus thirty-eight minutes.

4) The average rate of decay of the Surface Detonation Fall-out material is significantly longer than for the Underground Detonation Fall-out material. About fifty per cent of the radiation may be classified as very soft betas, absorbed by 28.5 mg/cm^2 aluminum with only five per cent penetrating 220 mg/cm^2 aluminum at this time.

5) Only glass-like beads have been found to contain the radioactivity in soil samples collected at thirty-one miles from the Surface Detonation Ground Zero. Eighty-one per cent of the radioactivity in these soil samples is separated out in the 75-150 micron fraction. Soil samples contaminated by the Underground Detonation, collected twelve miles from Ground Zero, have forty to fifty per cent of the radioactivity in the less than forty-four micron fraction and 2.5 per cent in the fraction larger than 150 microns. Only irregularly shaped, very friable dark colored particles are believed to be the Fall-out material from the Underground Detonation.

6) Fall-out material from the Underground Detonation is water and acid soluble. Over fifty per cent is soluble in 6 N HCl and ten per cent soluble in water.

7) Incomplete data on the uptake by radishes of radioactivity from soil contaminated by Fall-out material from the Underground Detonation indicates that Fall-out material is available and taken up by this

crop. Surface contamination is being leached to lower depths in the soil used for this experiment.

The work in progress on the study of the uptake of Fall-out material by crops from this agricultural soil in these contaminated flats is to be continued indefinitely and will be terminated only when it is no longer possible to secure meaningful data. This will be when radioactivity has decreased to a low level which can no longer be measured with a satisfactory degree of accuracy.

Additional material for study is to be obtained in the near future from the two craters. This will be utilized in extending the present work to include much higher radiation intensities. An experiment is to be initiated on the weathering or physical breakdown of "Janglite" in a soil as influenced by time, moisture, organic matter, soil type, etc.

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APPENDIX

Fig. 6 (page 29) is a map showing the approximate locations of forty-four soil sampling stations established in the proposed Fall-out area of Operation Jangle, Nevada. Surface soil samples (as well as representative flora and rabbits) were collected in September, 1951 for the purpose of establishing the natural "background" of the various components in a biological cycle.

REED
CEDAR PIPE LINE
AIR STRIP
CABINS
RESERVOIR
CABIN
WINDMILL
CABIN
CABINS
LINCOLN MINE
CORRAL
RESERVOIR
CABIN
STONE CABIN
RESERVOIR
BALD MT.
BASALT MT.
DONDALE RD.
BREAK IN MAP
WATER HOLE
JOHNIES WATER
WATER HOLE
CORRAL
WATER HOLE
GROOM MINE
WINDMILL
WATER TANK
GROOM LAKE
AIR STRIP
GOLD FLAT
GROOM PASS
MINE
TRUE NORTH
MAGNETIC NORTH
16° 10'
1952 ANNUAL CHANGE 1° DECREASE
PENOYER VALLEY
KAWICH VALLEY
DESERT RANGE
SAND SPRING VALLEY
EMIGRANT VALLEY
NTEMPIUTE

FIG. 6.

APPROXIMATE LOCATION OF NEVADA SOIL STATIONS
SEPTEMBER 1951

ROADS TRAVELED BY SOIL SURVEY GROUP - SEPTEMBER 1951
ROADS VERIFIED BY PARTICLE COLLECTING GROUP, LASL, LOS ALAMOS
ROADS NOT VERIFIED
PERMANENT LANDMARKS
(10) SOIL STATIONS

SCALE: 0 3 6 9 MILES

ESTABLISHED BY
SOIL SURVEY GROUP - ATOMIC ENERGY PROJECT
UNIVERSITY OF CALIF., LOS ANGELES

MAP PREPARED BY: J.W. NEEL, SOILS

BASE MAP BY
INDUSTRIAL HYGIENE GROUP
LOS ALAMOS SCIENTIFIC LABORATORY

DATE: JANUARY 1952